3.5.4 *Source Control of Disinfection By-Products*

Research is underway to evaluate the impacts of agricultural practices on the quality and quantity of TOC releases to the Delta. The contribution of natural wetlands to TOC concentrations found in Delta waters at drinking water intakes is not understood. The proposed restoration of wetlands through the CALFED Ecosystem Restoration Program may increase the total amount of TOC at drinking water intakes, increasing the potential to form DBPs. Changing channel flows and increasing the amount of tidal waters exchanged with the estuary (by increasing the tidal wetland volume) may increase the amount of bromide in Delta waters, significantly increasing DBP formation.

Research is underway to evaluate the impacts of agricultural practices on the quality and quantity of TOC releases to the Delta.

3.5.5 *Total Dissolved Solids, Salinity, Turbidity, and Nutrients*

A major problem during periods of low Delta outflow is tidal mixing of salt into the Delta channels. Salts are also present in fresh-water inflows to the Delta due to municipal and agricultural discharges. The most heavily concentrated source of agricultural discharges to the Delta is the San Joaquin River. The addition of a proposed activity may change contributions of salt to the Delta. The creation of wetlands as a part of the CALFED Ecosystem Restoration Program could contribute organic carbon to drinking water intakes and may change salinity outflow characteristics. In changing salinity outflow characteristics, the restoration projects also may contribute higher levels of bromide to drinking water intakes. The restored wetlands also may use more water, thereby reducing the fresh water available to repel salinity.

A major problem during periods of low Delta outflow is tidal mixing of salt into the Delta channels.

High salt levels in municipal water supplies can result in the following impacts: (1) reduced opportunities for water recycling and groundwater replenishment programs that depend on good source water quality to meet local resource program salinity objectives; (2) economic impacts on industrial and residential water users due to corrosion of appliances, plumbing, and industrial facilities; and (3) aesthetic impacts (salty taste) for drinking water consumers.

Consumer acceptance of drinking water is of major concern. Consumers want water that is both safe and pleasant to drink. Adverse taste, odor, and appearance problems originate from source water and the effects of treatment.

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Elevated TDS levels can adversely affect consumer acceptance and local water management and water use efficiency programs. Waters with naturally high TDS or salinity taste salty or may be unacceptably hard if calcium and magnesium levels are high. Consumers may resort to the use of ion-exchange systems (water softeners) to produce softer water. Ion-exchange systems are regenerated using

highly saline water, which is then flushed into the wastewater system. Dissolved solids in supply water and salt added during use result in higher TDS effluent from wastewater treatment plants. High TDS and salt make the water unacceptable for many wastewater reclamation applications. Multiple (more than once) reclamation cycles are increasingly difficult with higher TDS source water, and water management flexibility is reduced due to lack of ability to blend supplies from different sources. In addition, high TDS levels can cause direct economic impacts on industrial and residential water users, due to more rapid corrosion of infrastructure and appliances.

Turbidity and natural organic matter from stormwater runoff, wetlands, and agricultural activities provide a disinfectant demand that can require higher applied disinfectant doses or longer contact times. These materials also can harbor pathogens and protect them from disinfection. The major factors affecting physical removal processes for Delta waters in warm months are the presence and types of algae, water temperature, and pH.

The presence of nutrients (such as nitrate and phosphate), higher light levels, and warmer waters can enhance algal growth. Algal blooms are common in the Delta, in the aqueducts, and especially in storage reservoirs. Algae may cause physical clogging of filters and air binding, decreased filter runs, increased filter backwashing and decreased overall plant performance, and increased operating costs. The majority of algae are nontoxic; a few species are toxic or produce algal toxins. The presence of algae in the source water can cause large pH swings that can adversely affect coagulation, flocculation, and sedimentation. While algae are effectively removed by treatment, growth of some species of algae in raw waters produces objectionable odors and flavors in finished water, such as geosmin or methylisoborneol (MIB), that are not removed by conventional treatment. Warm and diurnally varying water temperatures can cause temperature inversions in upflow clarifiers that can result in large daily swings in settled water turbidities.

The presence of nutrients, such as nitrate and phosphate, higher light levels, and warmer waters can enhance algal growth.

During winter, high turbidities from storm-related events may necessitate reducing filtration rates to prevent filter breakthrough. Fluctuations in source water turbidity and in the specific components of turbidity over time require close attention to coagulant doses and proper filter operation. In addition, colder water temperatures reduce coagulation effectiveness, and the ability to achieve a filterable floc is made more difficult.

TOC, in and of itself, does not affect the physical removal process; but TOC levels affect the degree of coagulation, flocculation, and sedimentation required. For example, increases in TOC also increase the coagulant demand of the water, thus requiring more coagulant in order to effectively remove the turbidity. Enhanced coagulation for TOC removal is then required. Organic carbon affects treatment in two additional ways: pathogens may adhere to particulate organic carbon and be shielded from disinfection; and oxidative disinfectants do not

TOC, in and of itself, does not affect the physical removal process; but TOC levels affect the degree of coagulation, flocculation, and sedimentation required.

preferentially attack pathogenic organisms. Consequently, the more organic material in the water, the more disinfectant is spent oxidizing the organic matter.

3.6 APPROACH TO SOLUTION

The reader is reminded that Water Quality Program actions are intended to be implemented irrespective of the storage and conveyance alternative selected. Actions focus on source control and prevention, as well as a mix of other approaches that should be undertaken in addition to any water quality improvements that may result from selection of storage and conveyance options. Priorities for action were identified based on the apparent potential of an action to improve water quality and its capability for nearer term implementation. Assignment of priorities does not necessarily reflect the degree to which taking these actions is likely to correct the problems. Please refer to Section 3.7 for a discussion of the capabilities and limitations of planned CALFED water quality actions to address critical drinking water problems.

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The perception is growing that CALFED alternatives should be decided on in a phased approach over several years. Near-term drinking water regulations that pose problems for treatment will be promulgated prior to implementation of storage and conveyance options and realization of associated water quality benefits (Stage 1 of the D/DBP Rule was promulgated in December 1998, and Stage 2 of the regulation is targeted for May 2002). However, the effective date for Stage 2 may be up to 5 years if significant construction of treatment modifications is required. Moreover, a potential Stage 3 regulation, which may require even more stringent standards, should be developed in the next century. Accordingly, this section of the Water Quality Program Plan emphasizes activities likely to result in mitigation of adverse affects in the next several years. Proposals for research, demonstration, pilot, and longer term projects were discussed and developed.

The general approach to shorter term drinking water quality improvement was to reduce loadings of constituents of concern, reduce variability of source water quality, and enhance treatment flexibility, rather than rely on source replacement with higher quality waters or relocation of intakes to attain higher quality source waters. However, these latter options were discussed and developed as appropriate.

To begin to address the concerns as currently understood, the Drinking Water Work Group developed the following list of potential action items that can be implemented in the near future. This is a general list and not all items will apply to each withdrawal point or to each delivery system using Delta source waters.

Potential Action Items That Can Be Implemented in the Near Future

Agricultural drains	Treat drainage, relocate discharge points, release drainage during ebb tidal flows, implement BMPs, and modify land management practices to reduce loadings of TDS, nutrients, TOC, salinity, and selenium. Support land retirement programs for drainage-impaired lands, with local sponsorship.
Animal enclosures	Implement BMPs to reduce entry of fecal matter and associated TOC, nutrients, and pathogens into Delta drinking water sources.
Treated wastewater effluents	Improve treatment, relocate outfalls, encourage a watershed-based approach to permitting that evaluates cumulative impacts by using methods such as total maximum daily loads (TMDLs) of pollutants that affect drinking water quality.
Urban runoff	Treat drainage, relocate outfalls, encourage a watershed-based approach to permitting that evaluates cumulative impacts by using methods such as TMDL of pollutants that affect drinking water quality.
Algae control	Treat water to kill or remove algae, reduce nutrient sources, and evaluate operational measures.
Boating control	Develop and implement education, and support enforcement programs to reduce discharges of fecal matter and other wastes.
Local watershed management	Support community-based watershed efforts to reduce non-point sources of contaminants.
Blending/exchange	Develop a Bay Area blending/exchange project that enables Bay Area water districts to work cooperatively in order to address water quality and supply reliability concerns on a consensual basis. Facilitate water quality exchanges and similar programs to make high-quality Sierra water in the eastern San Joaquin Valley available to urban southern California interests.
Treatment	Invest in treatment technology demonstration.
Delta Drinking Water Council and Work Groups	Support the ongoing efforts of the Delta Drinking Water Council and its technical work group to develop necessary technical information on Delta water quality, identify appropriate treatment options, pursue source water exchange opportunities, and make other evaluations necessary to meet CALFED's goal of continuous improvement in Delta water quality for all uses.

Water Quality Program actions probably will minimally affect the levels of bromide, particularly for State Water Project (SWP) users. Bromide largely derives from sea-water intrusion. Diverting or repelling sea water or substituting cleaner source waters would require substantial reconfiguration of general Delta flows. Similarly, TDS and salinity from sea-water intrusion could not be effectively controlled by Water Quality Program actions.

Water Quality Program actions probably will minimally affect the levels of bromide, particularly for SWP users. Bromide largely derives from sea-water intrusion.

Some actions in this section could adversely affect parties who discharge wastes in the Delta and its tributaries. Prior to imposing these impacts, full project-specific environmental documents must be prepared to assess the complete range of proposed impacts, and mitigation measures must be proposed according to applicable laws.

CALFED is committed to continued stakeholder involvement in developing plans to address the water quality problems of the Bay-Delta estuary. Of particular importance is prioritizing actions for implementation. Stage 1A and Stage 1 actions have been identified in a preliminary fashion, but considerable evolution of these plans remains to be accomplished. The work in progress represented by Stage 1A and Stage 1 plans is subject to change, consistent with the CALFED adaptive management philosophy and in conjunction with ongoing stakeholder support and involvement. As a programmatic document, the CALFED Programmatic EIS/EIR is intended to establish the basic framework supporting detailed plans that will evolve with appropriate stakeholder input. Accordingly, currently identified Stage 1A and Stage 1 actions reflect progress made to date and are incomplete. Linkages of priority actions described in the Water Quality Program Plan and plans for Stage 1A and Stage 1 are not yet fully formed, nor is the exact sequence of water quality actions defined. Therefore, the information does not currently exist to enable the Water Quality Program Plan to be amended to include this detail.

CALFED is committed to continued stakeholder involvement in developing plans to address the water quality problems of the Bay-Delta estuary.

The following discussion addresses specific and regionwide approaches to decrease levels of nutrients, pesticides, pathogens, non-sea-water TDS, and TOC. In all cases, the approaches focus on means to reduce the impacts of constituents of concern irrespective of the storage and conveyance alternatives, consistent with the scope of the Water Quality Program component.

3.6.1 Bay-Delta Region

Priority Actions

1. Refine and expand the comprehensive CALFED Drinking Water Quality Improvement Strategy to identify and control drinking water parameters of concern.

The comprehensive strategy includes monitoring drinking water parameters of concern, conducting research, collecting information, and developing methods to reduce point and non-point wastewater sources. A strategy for implementing these measures will be further developed and refined based on the type of industry, state of technology, current regulations, cost, and other relevant considerations. This process will occur throughout the 30-year CALFED implementation period and will fully involve stakeholders.

2. Manage restoration projects to minimize adverse impacts and maximize benefits for drinking water quality.

   CALFED ecosystem restoration and other habitat restoration projects may cause adverse impacts on drinking water quality, particularly with regard to additional production of TOC from natural and created wetlands. CALFED should locate habitat restoration projects to avoid and reduce TOC pollution at intakes. Further research is warranted on this issue. Substantial uncertainty exists concerning TOC production and possible loadings from wetlands restoration, particularly with respect to production of more reactive TOC fractions. Proposals to evaluate these impacts have been developed by the U.S. Geological Survey (USGS) and DWR. CALFED should promote or implement these proposals.

   Substantial uncertainty exists concerning TOC production and possible loadings from wetlands restoration, particularly with respect to production of more reactive TOC fractions.

3. Conduct a pilot study on agricultural drainage control actions.

   Conduct a comprehensive pilot study of potential methods to reduce organic carbon loadings to the central Delta from agricultural drains. The goal is to identify and evaluate actions to reduce the quantity or improve the quality of drainage discharged to the central Delta. Actions should be economically feasible and result in improved water quality at the south Delta pumping plants. Potential actions to be investigated in the pilot study include:

   a. The feasibility of removing TOC in agricultural drainage. The initial focus could be on Twitchell Island and central Delta islands. Investigate various treatment technologies at a pilot-scale in field experiments.

   b. Relocating agricultural drains to discharge locations that are remote from the pumping plants. Investigate the economic feasibility of a central Delta drain that would discharge to the Sacramento River.

   c. Storing summer and, where feasible, winter drainage on individual islands in the central Delta and releasing the drainage downstream of urban intakes on the ebb tide.

d. Implementing land management projects, including conversion to early season crops, no-tillage farming practices, reduced frequency of winter leaching, conversion to wetlands, land retirement, and less water-intensive irrigation systems.

4. Implement full-scale agricultural drainage control actions.

   Implement cost-effective, full-scale treatment or management actions that would reduce agricultural drainage in order to reduce the contribution of agricultural drainage to TOC concentrations at drinking water supply pumps. Actions include, but are not limited to, relocation of drains, treatment of drain water, management of drain water, and land management.

5. Minimize pathogens from recreational boating.

   Wastewater dumped from houseboats, recreational boaters, and other recreation activities results in pathogen pollution of the watershed. Educational solutions could include programs such as developing partnerships with recreational interests; distributing materials at marinas, parks, and recreational supply stores; posting signs at recreational areas; and participating in community events.

   Wastewater dumped from houseboats, recreational boaters, and other recreation activities results in pathogen pollution of the watershed.

   A stakeholder process is proposed to evaluate additional educational and regulatory needs. Discussions would include the California Department of Boating and Waterways; San Francisco Bay Estuary Project; boating and marina interests; other recreational interests; park departments; and enforcement agencies such as the U.S. Coast Guard, RWQCB, and county sheriff departments. CALFED funding could be used to support identified solutions through educational programs; bans on waste discharges; and facility improvements, such as improved or additional pumpout and restroom facilities. Educational programs such as those in the California Department of Boating of Waterways, the Sacramento River Watershed Program, and local and other efforts will be considered for expansion.

6. Reduce wastewater and stormwater sources of drinking water constituents of concern.

   Urbanization of the Bay-Delta, as described in the sections to follow, may result in substantial degradation of Bay-Delta waters. It is recognized that wastewater and stormwater discharges may result in undesirable loadings of pathogens, nutrients, TOC, and TDS; and that the development of NPDES permits provides opportunities to address impacts on drinking water. Expansion of the wastewater facilities and urbanization of land in the Delta area are identified as potential sources of increased pollutant loadings. CALFED and stakeholders, including the SWRCB, DWR, California

   Expansion of the wastewater facilities and urbanization of land in the Delta area are identified as potential sources of increased pollutant loadings.

Department of Health Services (DHS), drinking water and wastewater utilities, and county planning departments, should participate in the development of a comprehensive watershed protection program to minimize impacts of increasing wastewater discharges into the waters of the Sacramento-San Joaquin Delta estuary and its tributaries.

Currently identified Stage 1 and Stage 1A actions are incomplete and can be augmented through ongoing stakeholder involvement to include such elements as TMDL development and investigating the sources of pathogens in the system. Such actions may be included in the Stage 1 and/or Stage 1A lists.

7. Evaluate treatment plant operational and technological needs.

   Evaluate treatment plant operational and technological needs to reduce brominated and chlorinated DBP formation. Also evaluate whether common treatment system technology, coupled with operational changes, are sufficient to meet existing and proposed drinking water standards. Support development of new advance treatment technologies such as ultraviolet and chlorine dioxide disinfection and membrane filtration.

8. Identify problems and solutions to urban runoff.

   Current and future urban runoff from Delta and tributary urban areas are potential sources of pathogens and other contaminants. The Sacramento Stormwater Management Program, one of several local stormwater programs, currently is conducting literature reviews and preparing an issue paper to assess this potential problem. CALFED should continue efforts to better identify problems and solutions, through such activities as literature reviews, research, and public education activities. CALFED also should participate in implementing solutions. (This action will be coordinated with the action listed action above to reduce wastewater and stormwater sources of drinking water constituents of concern.)

Current and future urban runoff from Delta and tributary urban areas are potential sources of pathogens and other contaminants.

9. Reduce the loading of TDS to the Sacramento and San Joaquin Rivers and to the Delta.

   The salinity and selenium sections of this Water Quality Program Plan identify a number of approaches to address TDS loading in the Sacramento and San Joaquin Rivers and the Delta. These approaches could reduce TDS levels at drinking water intakes.

10. Conduct additional studies concerning algae and macrophyte growth.

    The excessive growth of algae and macrophytes in water conveyance and storage facilities is a concern for drinking water suppliers. The presence of

The excessive growth of algae and macrophytes in water conveyance and storage facilities is a concern for drinking water suppliers.

nitrogen and phosphorus nutrient compounds in Delta water supplies, at levels that readily support the growth of algae, contributes to the excessive growth of algae and macrophytes in water supply facilities. Additional studies are needed to more fully understand the sources and loadings of nutrients in the watershed. Also needed is increased understanding of the relationship between nutrient concentrations and loads in the Delta watershed, and the occurrence of excessive algae and macrophyte growth in water conveyance and storage facilities containing Delta water supplies. (See also information needed to address low DO and oxygen-depleting substances.) In addition, the role of other factors affecting algae growth, such as the operation and maintenance of water conveyance and storage facilities, warrants further assessment. Operational controls are discussed further in individual sections.

11. Implement source controls in the Delta and its tributaries.

CALFED, with CalEPA—specifically the SWRCB and the CVRWQCB, DHS, and DWR, with assistance from EPA—will coordinate a comprehensive source water protection program. This program will include identification and implementation of appropriate pollutant source control measures, focused regulatory and/or incentive programs targeting priority pollutants, development of monitoring and assessment programs, and infrastructure improvements to separate drinking water intakes from irremediable sources of pollutants. The following actions are planned:

The source water protection program will include identification and implementation of appropriate pollutant source control measures, focused regulatory and/or incentive programs targeting priority pollutants, development of monitoring and assessment programs, and infrastructure improvements to separate drinking water intakes from irremediable sources of pollutants.

- The CVRWQCB, with support from CALFED and DHS, will establish a comprehensive state drinking water policy for Delta and upstream tributaries by the end of 2004.

- As part of the CALFED Science Program, develop comprehensive monitoring and assessment program by the beginning of 2003.

- Evaluate and determine whether additional protective measures (regulatory and/or incentive-based) are necessary to protect beneficial uses by the end of 2004.

Consistent with the above policy, the CVRWQCB—with support from DWR and DHS—will begin implementation of appropriate source control measures (for example, advanced wastewater treatment and local drainage management practices) by the end of 2006.

12. Develop a Bay Area blending/exchange project that enables Bay Area water districts to work cooperatively in order to address water quality and supply reliability concerns on a consensual basis.

This is an "umbrella" project that will evaluate a range of potential changes to existing infrastructure and institutional arrangements in order to encourage a regional approach to water supply operations. Specific actions include:

- Identify potential local partners and develop agreements as needed for necessary studies by July 2001.
- Secure authorization and funding for feasibility studies by July 2001.
- Begin feasibility study and environmental review July 2001; complete feasibility study by July 2002.
- Complete environmental review, documentation, and preliminary design on selected alternative by the end of 2003.
- Finalize agreements with project participants by mid-2004.
- Obtain necessary authorizations and funding (including any required local voter approval) by the end of 2004 and begin construction by the end of 2005.

Information Needed

1. Refined measurements of sources and loadings of drinking water quality parameters of concern.

   The sources and loadings of parameters of concern that affect drinking water quality in the Delta, at drinking water intake points and in storage reservoirs, should be identified and measured. The current understanding of pollutant loadings from non-point sources, stormwater drains, and agricultural drains is limited. Improved characterization of drinking water contaminant loadings will facilitate identification and implementation of cost-effective pollutant reduction actions as a part of the Water Quality Program. CALFED should institute a comprehensive study of the magnitude, extent, and origin of these pollutants (TOC, TDS, and pathogens). The resulting report should address a strategy to reduce pollutant loading from permitted discharges and non-point sources.

   The current understanding of pollutant loadings from non-point sources, stormwater drains, and agricultural drains is limited.

2. Evaluation of drinking water treatment options.

   Because utilities will need to comply with upcoming and planned drinking water regulations before changes in storage and conveyance could provide significantly improved water quality, most utilities have begun planning and